Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/453
UNITED ARAB REPUBLIC
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

THE UTILIZATION OF THE 2MW RESEARCH REACTOR OF THE UARAEE (UA-RR-1) FOR PHYSICS RESEARCH AND ISOTOPE IRRADIATION

I. Hamouda, O. El Mofty, Y. El Meshad and M. Elnagdy
UAR Atomic Energy Establishment

The UA-RR-1 is a pool type reactor which was purchased in the USSR on the basis of a bilateral agreement. It was made critical in July 1961, and attained its nominal power of 2MW during the following September. The purpose of installing the reactor is to conduct research in the fields of physics, chemistry and biology, to produce radioisotopes and to provide training in reactor engineering. This paper will deal with the operating conditions and co-ordination of the different uses of the reactor as well as the development of the physics research programme utilizing this reactor.

During the construction and assembly period of the reactor, the few technical and scientific staff available took an active part in the various problems associated with this period. Very little effort was left for planning and preparing for the utilization phase. Such a situation is perhaps characteristic of many countries developing their traditions in nuclear sciences.

The programme of physics research was planned taking into consideration the many facilities for research offered by the reactor, namely nine horizontal channels, one thermal column and several irradiation channels. Also, it was felt that from the point of view of reactor exploitation economy, it would be better if the reactor were utilized for several purposes of several experiments at the same time. During the last two years the number of physics research workers utlizing the reactor has reached about forty people doing ten experiments. These experiments include: thermal and epithermal neutron flux determination, fast neutron flux and spectrum measurement using activation detectors, angular correlation of prompt gamma rays and direction

of flight of fission fragments, measurement of inelastic scattering cross-section and angular distribution of scattered fission neutrons, studies of neutron capture gamma rays, measurement of thermal neutron spectra and cross-sections using a mechanical chopper, neutron diffraction studies, radiation effects on glass, radiation effects on the order-disorder transformation in alloys.

In developing this programme we invited specialists from different research institutions. Some foreign specialists were invited either through the IAEA or through bilateral agreements. A number of 15 junior scientists are sent abroad for training, either through IAEA fellowships or through scholarships.

After the erection of a radioisotope production laboratory in the vicinity, full use is made of the available irradiation facilities. The irradiation channels were divided into three groups depending on the half-lives of the produced isotopes. Several facilities have been developed to facilitate dealing with the different problems of the isotope irradiation process such as: loading and unloading of samples, transportation of irradiated samples, irradiation of long-lived isotopes and disposing of solid waste. The reactor is now being operated for one shift per day, five days a week. Each couple of weeks, the reactor is operated for a continuous run of 48 hours at full power.

For the production of long-lived isotopes such as Co^{60} and Ir^{192} under the adopted operational schedule, calculations showed that the produced activity can be estimated by assuming that the reactor is working continuously at 30% of its full power.

A firm organization is adopted to guarantee the safety of personnel and the safe operation of the reactor. Since the reactor reached criticality in July 1961, it has operated for about 4000 MWh, without any accident. There has been no long "out of operation" periods caused by major repairs or adjustments.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/454
UNITED ARAB REPUBLIC
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

REACTORS GRADE URANIUM FROM UAR MONAZITE BY NEWER TECHNOLOGIES

Part I: The chalk-sintering complex choride fixation approach

Part II: The Trilaurylamine direct treatment of rare-earth barren digests

Michel Y. Farah
Nucl. Chem. Dept., UAR Atomic Energy Establishment

Both acid and alkali processes for separating reactor grade uranium, thorium or high purity individual rare-earths suffer the drawbacks of:

- lengthy fractionation in phosphate presence;
- excessive grinding before alkali leaching;
- necessity of using few solvents for refining either thorium or uranium to reach nuclear purity grades by expensive and elaborate lengthy devices.

The present investigation describes two new approaches:

Part I: The chalk sintering - hydrochloric acid leaching and ion-exchange uranium fixation as chloride complex, followed by wet reduction to uranium dioxide or fluorination.

This is a modification of the French alkali patent whereby:

- grinding and dressing of 98% monazite to -325 mesh powder is replaced by sintering at 825°C using various fluxes particularly chalk;
- after serubbing the sinter, leaching of monazite by volume to volume HCl;
- saturating the liquor by commercial salt and adjusting its EMF to 0.4 volt;
- fixing the complex uranyl chloride on an ion-exchange resin strong base;
- washing the column from thorium and rare-earth by 2.5 bed volume 1:1 HCl then eluting uranium by pH 1 acid HCl or fluoride;

- reduction by versatile reductors and wet precipitation of uranium dioxide fuel material;
- eventual refining of chloride eluates as such by TBP or TLA/MIK.

Part II: The extraction of reactor grade uranium directly by Trilaurylamine on the rare-earths barren monazite digests.

This is an original modification of the AMEX process:

- by adjusting digests of sulphate attacks of monazite to pH 1.1 by various means to strip majority of thorium, keeping liquors only rare-earth barren;
- following this by extracting uranium through Trilaurylamine sulphate, while defining parameters, optimal conditions, drawing isotherms as also investigating the kinetics of the system and number of theoretical stages according to McCabe-Thiele's diagrams;
- presenting bench-scale batch and continuous mixer-settler data for uranium refining as well as spectrographic analyses for their specifications fulfilment.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/455
UNITED ARAB REPUBLIC
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

COEXTRACTION OF THORIUM AND CERIUM BY NEUTRAL PHOSPHORUS ORGANIC COMPOUNDS

A.M. Alian
Nucl. Chem. Dept., UAR Atomic Energy Establishment

The study of coextraction of thorium and cerium is very important due to the occurrence of the second in concentrates of the first obtained in the processing of monazite.

The values of the separation coefficient of the two elements could be calculated on the basis of partition data. However, the partition coefficient values are affected by the metal concentration in the aqueous phase; consequently the values of the separation coefficient are changed. Moreover it was found that cerium partition coefficient sharply decreases with increase of thorium concentration in the aqueous phase. This is due to competition between cerium and thorium for the free solvent; thorium forms more stable complexes with the solvent molecules. The separation coefficient of the two elements (ξ) can be calculated on the basis of the confirmed extraction mechanism. ξ is expressed by the following relation:

$$\xi = D_{Th} / D_{Ce} \qquad (1)$$

On the basis of the extraction mechanism of the two elements, it is easy to show that ξ can be expressed by the following equation:

$$\xi = \frac{K_{Th}}{K_{Ce}} \cdot \frac{[NO_3^-] \left(1 + \Sigma \beta'_j [NO_3^-]\right)}{S \cdot \left(1 + \Sigma \beta_j [NO_3^-]\right)} \qquad (2)$$

Where K_{Th} and K_{Ce} are the equilibrium constants of the extraction reaction of the two elements, β_j and β'_j are the stability constants of thorium and cerium complexes with the NO_3^- ions.

β_j and β'_j and also K_{Th} and K_{Ce} for TBP and DAMPK (which is a member of alkyl phosphonates) were determined experimentally.

The value of ξ thus depends on the total nitrate ion concentration in the aqueous phase and on the free solvent concentration in the organic phase. It is to be noted that the above equation holds only for the extraction at low acidities. Equation (2) may be written in the following form:

$$\xi = \frac{K_{Th}}{K_{Ce}} \cdot \frac{1}{S} \cdot f\left([NO_3^-]\right) \qquad (3)$$

The values of $f([NO_3^-])$ and the corresponding ξ values were calculated at different nitrate ion concentrations in the aqueous phase for 1 M solvent concentration. It was found that the calculated and experimental ξ values agree with each other which is an indication of the correctness of the given mechanism. It was found also that the separation coefficient of thorium and cerium has a maximum value at an equilibrium nitrate concentration of 1.6 M. The maximum value of 1 M TBP is equal to ~48.

In technology thorium is usually extracted from solutions with high metal concentrations, and therefore the solvent will be almost completely saturated with thorium. This brings about an increase in the value of ξ as indicated by equation (3).

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/456
UNITED ARAB REPUBLIC
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

NUCLEAR GRADE ZIRCONIUM FROM EGYPTIAN ZIRCON

M.Y. Farah and I.S. El-Yamani
UAR Atomic Energy Establishment

The manufacture of cladding zircalloys implies starting with 98% ore and silica-free zirconia before dehafnization and metallurgical elaboration.

In a previous work(*) the preparation of high purity zirconia - containing only 0.04% silica, trace iron and titanium from unground placers by soda sintering - was described.

The present investigation resumes dehafnization study of the fed zirconia still containing 1.4% HfO_2. The usual organophosphorus and amine solvents were re-examined in view of enhancing maximum loading charge and introducing cheaper commercial varieties. Tributylphosphate as 60% solution is suggested after thorough examination of numerous diluents besides white spirit. The efficiency of diluents follows the order: odourless kerosene methyl isobutyl ketone > xylol > n-hexane > benzene > cyclohexane > toluene. Examined variables included: time of contacting (1-5 minutes), concentration of free nitric acid (5-8 molar), of fed zirconium (5-100 gm Zr/litre), saltingout agents (about 3.5 molar nitrates). For diluted aqueous feed: 10 gm Zr/litre, the added cations enhanced separation in the order: Al > Mg > Li > Na > NH_4 - nitrates. Optimals were reached after two minutes contacting time and using 6.5M free nitric acid. The maximum loading charge (80 gm/litre) compared favourably with values obtained in the competitive thiocyanate-hexone refining process, although the separation factor obtained in the present study approximates three-fold that of the

(*) M.Y. Farah and S.I. El-Yamani: "The Alkali Sintering of Egyptian Zircon Placers".

German process signifying its feasibility on smaller mixer-settler batteries.

In the examination of long-chain aliphatic and aromatic amines, the latter were found to give in general better results than the former and the tertiary were more favourable than the secondary and still more than the primary ones. Amines examined included: Armeen C,S,T, TD, HTD of Armour Hess and FB-Amine 10, 12, 16, 17, 18 of Float-Ore firm. Tri- and dibenzylamine and trilaurylamine hydrochlorides as well as sulphate liquors were studied and the effect of lowering temperature, increasing acidity and changing diluents were examined as for TBP runs.

Optimal results were obtained with tribenzylamine while cooling and equally good but slightly lower results were encountered with the cheaper commercial amines in general justifying their applicability as effective competitive solvents for TBP owing to still higher separation factors.

Isotherms were drawn based on analyses of both phases for Zr by EDTA Bi back titration and for Hf using tracer Hf^{181}.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/457
UNITED ARAB REPUBLIC
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

SEPARATION AND PURIFICATION OF CERTAIN RADIOISOTOPES FOR MEDICAL USE

A.A. Abdel-Rassoul, H. Fouad, A. Abdel-Aziz,
S.S. Wahba and Salah Mohammad
Nucl. Chem. Dept., UAR Atomic Energy Establishment

This paper deals with newly investigated procedures for the separation and purification of certain radioisotopes for medical applications. The methods described are recommended for producing S^{35}, Ca^{45}, Sc^{46}, Sc^{48}, Ag^{111} and Au^{199} in carrier-free state, Cr^{51} of increasing specific activity, and carbon-coated preparations of mixed Au^{198} and Ag^{111} radioisotopes, as well as carbon suspensions with inactive gold impregnated with Ag^{111}. All radionuclides separated have a radiochemical purity exceeding 99%.

A simple method is developed for separating carrier-free S^{35} ($T_{\frac{1}{2}}$ = 87d) from neutron irradiated KCl free from any contaminating P^{32} activity. The behaviour of both S^{35} and P^{32} activities on the strongly basic anion exchanger, Dowex-1, has been studied and the optimum conditions for their separation are used. On the other hand, both carrier-free Ca^{45} ($T_{\frac{1}{2}}$ = 153d) and Sc^{46} ($T_{\frac{1}{2}}$ = 84d) are separated from pile-irradiated alkali fluorotitanates. In such a case, the behaviour of both radionuclides on the strongly acidic cation exchanger, Dowex-50, in differing hydrochloric acid concentrations has been investigated and the two radioisotopes fractionally separated. Both products are free from any titanium traces. Further, carrier-free Sc^{48} ($T_{\frac{1}{2}}$ = 44h) is prepared from neutron irradiated vanadium targets by solvent extraction/ion exchange techniques.

The methods described for the production of both carrier-free Ag^{111} and Au^{199} activities are based on co-crystallization technique. Ag^{111} ($T_{\frac{1}{2}}$ = 7.6d) is separated in saline solution or by further electrodeposition on Pt-electrode from pile-irradiated palladium targets. Carrier-free Au^{199} ($T_{\frac{1}{2}}$ = 3.15d), on the other hand, is separated from neutron irradiated platinum.

Moreover, Cr^{51} of increased specific activity is separated from neutron irradiated K_2CrO_4 targets (Szilard-Chalmers reaction) by two successive purification steps on the strongly basic anionite, Dowex-1.

Finally, carbon-coated preparations with mixed Au^{198} ($T_{\frac{1}{2}}$ = 2.7d) and Ag^{111} radioisotopes as well as suspensions with Ag^{111} on inactive gold-on-carbon are produced. In both cases, carrier-free Ag^{111} is readily deposited on carbon particles previously coated with gold. The latter suspension is preliminarily formed by mixing Au^{198} and/or gold solution with carbon particles followed by reduction with ascorbic acid, respectively. Both preparations possess outstanding stability resisting desorption and are not sedimented before 30 minutes duration.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/458
UNITED ARAB REPUBLIC
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

NEW DEVELOPMENTS IN THE ACCELERATED ISOTOPIC LABELLING OF ORGANIC COMPOUNDS

N.A. Ghanem and H.T. Hanna

Labelled organic compounds are finding increasing useful applications in the scientific, medical, biological and chemical fields as well as in the organic industries. After reviewing previous work, the paper describes new developments in producing these compounds in the laboratory in a matter of a few minutes and points out the method's advantages.

A laboratory microwave generator was used to produce microwave energy of about 12 cm wave length, 2425 MHz frequency and continuously variable power output between 20 and 250 W. This was used as a tool for accelerating exchange reaction, but not ion acceleration, between tritium gas and a variety of anaesthetic and other products to produce unspecific and specific labelling in the order of 50mC/g or more depending on the amount of material. Among these products are carbocaine, procaine, tetracaine, xylocaine and L-cocaine. The energy was concentrated in a spherical specially constructed but simple cavity where the resonance frequency obtained by a tuning device allows an electrodeless discharge to be produced in the reaction tube.

Two new features are stressed upon. The first is the simultaneous recording of the course of reaction. This was achieved by coupling the vacuum gauge to a speedomax pen recorder of 10 mV total range, whereby the change of gas pressure with microwave energy is recorded without interruption. With most of the compounds a decrease of pressure was noted, while with the rest a gradual increase was marked. Conclusions are drawn as to the relative importance of the power of the discharge and the distance of the target material from the plasma zone. The second is the use of a bent tube. The material to be labelled is powdered and mixed with glass-wool in a side bent tube connected to the main tube in which the discharge takes place.

In this way, the material is protected from UV radiation and is far from charged entities. The method is therefore suitable for general labelling including radiation and heat sensitive material as no sparking whatsoever is involved. When this tube is cooled in liquid nitrogen, liquids and condensible gases can also be labelled, as in the cases of benzene and ethylene oxide.

The method is characterized by presence of minimum decomposition products where relatively simple purification techniques are adequate to get radiochemical purity. The results supply further evidence to the atom-molecule mechanism proposed earlier by one of the authors, as no charged particles from the plasma zone are likely to reach the target material in the bent section. Fixation yields and efficiencies are calculated.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/459
SWITZERLAND
February 1964
Original: FRENCH

Confidential until official release during Conference

Abstract

UNDERGROUND CONTAINMENT FOR THE EXPERIMENTAL NUCLEAR POWER STATION LUCENS

E. Binggeli and P. Verstraete
Bonnard and Gardel, Consulting Engineers, Lausanne
A. Sutter
Atomelectra Ltd., Zurich

The 30 MWth experimental nuclear power station presently under construction at Lucens is equipped with a pressure-tube reactor, moderated by heavy water and cooled by carbon dioxide.

In view of the underground location of the plant an economic design for the containment was developed using conventional civil engineering construction techniques while taking advantage of the natural properties of the surrounding rock. Such design provides sufficient protection even in the event of the maximum hypothetical accident.

Extensive investigations on the geology and hydrology of the site have shown that the rock mass, a porous homogeneous and highly compact molasse, typical of sedimentary configuration, can be used as a filter for particulate radioactivity as well as temporary storage for fission gases released after a severe accident without undue risk to the surroundings.

With the help of laboratory tests and measurements carried out in an experimental cavern excavated on the site the various mechanisms governing decompression of the containment and release of gases to the rock could be investigated. Likewise, the techniques required for building and lining the containment could be established.

The additional lining of the entire reactor cavern, consisting of a multilayer coating of bitumen and thin aluminium foils, will contain the initial

Translation provided by courtesy of the submitting Government

effects of a severe reactor accident. The resulting overpressure will be partly reduced through cooling effects and condensation of steam. The remaining overpressure is then reduced by opening decompression valves equipped with filters which will release the contained gases (mainly CO_2, air, noble gases and halogen vapours) into the surrounding porous rock. Therefore the potential danger entailed by a highly contaminated atmosphere under pressure is greatly diminished.

The tests in the experimental cavern have shown that during decompression gases will flow only a limited distance into the rock; further progression is very slow and occurs by molecular diffusion.

Based on experimental evidence the present paper then shows that containment safety requirements can be met by adequately combining the inherent site characteristics and construction techniques.

Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/460
SWITZERLAND
February 1964
Original: FRENCH

Confidential until official release during Conference

Abstract

ON THE LONG-TERM MECHANICAL PROPERTIES OF METALS USED AT ELEVATED TEMPERATURES AND SUBJECTED TO NEUTRON IRRADIATION

by W. Siegfried and S. Zimering
Battelle Memorial Institute, Geneva

The following two fundamental questions are discussed:

1) In what measure can thermodynamic extrapolation methods help us to determine the long-term properties of metals at elevated temperatures ?

2) Will it be possible to determine the long-term properties of metals irradiated by neutrons by an extension of the classical thermodynamic extrapolation methods for metals without irradiation ?

To (1):

By evaluation of the known results of in-pile relaxation tests, we conclude that thermodynamic extrapolation methods can be used for the case where irradiation by neutrons only produces interstitials and vacancies. Furthermore, we find that in this case it is sufficient to perform a few tests only under irradiation, and deduce from them and from tests without irradiation the long-term properties.

To (2):

The solution of this problem requires a careful analysis of the physical basis of the already known thermodynamic extrapolation

Translation provided by courtesy of the submitting Government

methods. First of all, we have to see whether it is possible to express the complicated processes taking place during the creep of industrial steels by a simple Arrhenius equation. Furthermore, it will be necessary to clarify the influence of mechanical instability, such as formation of a constriction or intergranular fissures, on the long-term properties. Such an investigation will permit us to determine if time-to-rupture tests can partly be replaced by warm-hardness tests.

It is concluded that the simple Arrhenius equation gives only inaccurate results for the extrapolation of time-to-rupture tests of industrial alloys, and therefore a more complicated form has to be taken. This new form has an energy of activation and an entropy of activation, determined by another Arrhenius equation; and now the speed of creep as a function of the stress is no longer an exponential function, but a real iterate of logarithmic-exponential function, which is an extension of the first one.

From the investigation of the relations between the instability resulting from the formation of a constriction and the instability resulting from the formation of intergranular fissures, it is concluded that the form of the time-to-rupture curve (time-to-rupture as a function of the stress) is significantly influenced by the mechanical instability due to the formation of a constriction. It is not possible to describe this process by an Arrhenius equation. The thermodynamical evaluation of time-to-rupture tests with regard to the contraction of the broken specimens enables us to determine the influence of the geometrical instability. It has been found that the activation entropy for the formation of intergranular fissures shows the same dependence on the stress as the activation entropy for the creep process. From this behaviour, the conclusion can be drawn that the formation of intergranular fissures is initiated by nuclei developed during the creep process. This fact gives a basis for investigating to what extent time-to-rupture tests can be replaced by warm-hardness tests.